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To: Bena Miller **From:** Don Coulman

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Phone: (703) 305 0643 **Date:** 01/23/2003

Re: Applic. # 09/915,978 ***For problems with this fax contact:***

Don Coulman 541.715.1694

• **Comments:** Bena Miller,

Attached are several pages from various references to help facilitate our discussion on Wednesday 01/29/03 at 10:00 AM EST on the interpretation of claims 6, 11, and 12. I would also like to draw your attention to article entitled "The Flight of the Frisbee" from Scientific American submitted in the IDS

Regards,

Don Coulman

Exploratorium Exhibit & Phenomena Cross-Reference

•Phenomena•Phenomena•Phenomena•Phenomena•Phenomena•

AERODYNAMIC LIFT

When a wing is propelled through the air, there is a force upward on the wing due to the Bernoulli e (air passing more quickly over the top of the wing than the bottom of the wing produces a lower pressure on the upper surface, hence a lift). There is also an upward force due to the air deflected downward from the bottom of the wing. These two forces taken together tend to lift the wing agains gravity and is therefore known as LIFT.

Exhibits that show this phenomenon:

Visible Effects of the Invisible

Related phenomena:

Aerodynamic Drag
Bernoulli Effect
Friction - Air
Laminar Flow
Turbulent Flow

Additional information & resources:

We'll be adding interesting info and links here. If you have a good one, we need your feedback

Exploratorium Exhibit & Phenomena Cross-Reference

•Phenomena•Phenomena•Phenomena•Phenomena•Phenomena•

BERNOULLI EFFECT

The pressure is lower in a moving fluid than in a stationary fluid. This effect is called the Bernoulli effect. If you put the convex side of a spoon into a smooth stream of water from the faucet, you will the spoon pulled into the stream. The higher pressure outside the moving fluid pushes the spoon intc lower pressure water.

A ball balances in a stream of air from a blower. The ball is strongly held in the lower pressure strea air.

✔ Exhibits that show this phenomenon:

Balancing Ball

✔ Related phenomena:

✔ Additional information & resources:

We'll be adding interesting info and links here. If you have a good one, we need your feedback

McGraw-Hill Dictionary of Scientific and Technical Terms

Fifth Edition

Sybil P. Parker
Editor in Chief

McGraw-Hill, Inc.
New York San Francisco Washington, D.C.
Auckland Bogotá Caracas Lisbon London Madrid Mexico City Milan
Montreal New Delhi San Juan Singapore Sydney Tokyo Toronto

air escape [DES ENG] A device that is fitted to a pipe carrying a liquid for releasing excess air; it contains a valve that controls air release while preventing loss of liquid. ['er ə,skāp]

air-exhaust ventilator [MECH ENG] Any air-exhaust unit used to carry away dirt particles, odors, or fumes. ['er ig'zȯst 'ven·tə,lād·ər]

air feed [MET] In thermal spraying, transmittal of powdered material by air pressure through the gun into the heat source. ['er ,fēd]

airfield [CIV ENG] The area of an airport for the takeoff and landing of airplanes. ['er,fēld]

air filter [ENG] A device that reduces the concentration of solid particles in an airstream to a level that can be tolerated in a process or space occupancy; a component of most systems in which air is used for industrial processes, ventilation, or comfort air conditioning. ['er ,fil·tər]

airfloat clay [MIN ENG] Fine particles of clay obtained by air separation from coarser particles following a grinding operation. ['er,flōt 'klā]

air flotation *See* dissolved air flotation. ['er flō'tā·shən]

airflow [FL MECH] **1.** A flow or stream of air which may take place in a wind tunnel or, as a relative airflow, past the wing or other parts of a moving craft. Also known as airstream. **2.** A rate of flow, measured by mass or volume per unit of time. [MIN ENG] *See* air current. ['er,flō]

airflow duct [ENG] A pipe, tube, or channel through which air moves into or out of an enclosed space. Also known as air duct. ['er,flō ,dəkt]

airflow orifice [ENG] An opening through which air moves out of an enclosed space. ['er,flō 'ȯr·ə·fəs]

airflow pipe [ENG] A tube through which air is conveyed from one location to another. ['er,flō ,pīp]

airflow stack effect [FL MECH] The variation of pressure with height in air flowing in a vertical duct due to a difference in temperature between the flowing air and the air outside the duct. ['er,flō 'stak i,fekt]

airfoil [AERO ENG] A body of such shape that the force exerted on it by its motion through a fluid has a larger component normal to the direction of motion than along the direction of motion; examples are the wing of an airplane and the blade of a propeller. Also known as aerofoil. ['er,fȯil]

airfoil profile [AERO ENG] The closed curve defining the external shape of the cross section of an airfoil. Also known as airfoil section; airfoil shape; wing section. ['er,fȯil 'prō,fīl]

airfoil section *See* airfoil profile. ['er,fȯil ,sek·shən]

airfoil shape *See* airfoil profile. ['er,fȯil ,shāp]

airfoil-vane fan [MIN ENG] A centrifugal-type mine fan; the vanes are curved backward from the direction of rotation. ['er,fȯil ,vān 'fan]

airframe [AERO ENG] The basic assembled structure of any aircraft or rocket vehicle, except lighter-than-air craft, necessary to support aerodynamic forces and inertia loads imposed by the weight of the vehicle and contents. ['er,frām]

air-fuel mixture [MECH ENG] In a carbureted gasoline engine, the charge of air and fuel that is mixed in the appropriate ratio in the carburetor and subsequently fed into the combustion chamber. ['er 'fyül ,miks·chər]

air-fuel ratio [CHEM] The ratio of air to fuel by weight or volume which is significant for proper oxidative combustion of the fuel. ['er 'fyül ,rā·shō]

air furnace [MET] **1.** A furnace using a natural air draft. **2.** A furnace in which the metal is melted by a flame originating from fuel burned at one end, passing over the hearth in the middle, and exiting at the other end. ['er ,fər·nəs]

air gage [ENG] **1.** A device that measures air pressure. **2.** A device that compares the shape of a machined surface to that of a reference surface by measuring the rate of passage of air between the surfaces. ['er ,gāj]

air gap [ELECTR] **1.** A gap or an equivalent filler of nonmagnetic material across the core of a choke, transformer, or other magnetic device. **2.** A spark gap consisting of two electrodes separated by air. **3.** The space between the stator and rotor in a motor or generator. [ENG] **1.** The distance between two components or parts. **2.** In plastic extrusion coating, the distance from the opening of the extrusion die to the nip formed by the pressure and chill rolls. **3.** The unobstructed vertical distance between the lowest opening of a faucet (or the like) which supplies a plumbing fixture (such as a tank or washbowl) and the level at which the fixture will overflow. [GEOL] *See* wind gap. [PETRO ENG] In an offshore drilling operation, the distance from the normal sea surface level to the bottom of the base of the drilling platform. ['er ,gap]

air gas [MATER] A gaseous fuel made by blowing air through a coal or coke bed so that CO_2 is reduced to CO. ['er ,gas]

airglow [GEOPHYS] The quasi-steady radiant emission from the upper atmosphere over middle and low latitudes, as distinguished from the sporadic emission of auroras which occur over high latitudes. Also known as light-of-the-night-sky; night-sky light; night-sky luminescence; permanent aurora. ['er,glō]

air grating [BUILD] A fixed metal grille on the exterior of a building through which air is brought into or discharged from the building for purposes of ventilation. ['er ,grād·iŋ]

air-ground communication [COMMUN] Two-way communication between aircraft and stations on the ground. [,er ,graund kə,myü·nə'kā·shən]

air gun *See* air rifle. ['er ,gən]

air hammer *See* pneumatic hammer. ['er ,ham·ər]

air-handling system [MECH ENG] An air-conditioning system in which an air-handling unit provides part of the treatment of the air. ['er ,hand·liŋ ,sis·təm]

air-handling unit [MECH ENG] A packaged assembly of air-conditioning components (coils, filters, fan humidifier, and so forth) which provides for the treatment of air before it is distributed. ['er ,hand·liŋ ,yü·nət]

air-hardening steel [MET] A steel whose content of carbon and other alloying elements is sufficient for the steel to harden fully by cooling in air or any other atmosphere from a temperature above its transformation range. Also known as self-hardening steel. ['er ,härd·niŋ 'stēl]

airhead [ORD] A designated geographical area in an area of operations used as a base of supply and evacuation by air. ['er,hed]

air heater *See* air preheater. ['er ,hēd·ər]

air-heating system *See* air preheater. ['er ,hēd·iŋ 'sis·təm]

air heave [GEOL] Deformation of plastic sediments on a tidal flat as a result of the growth of air pockets in them; the growth occurs by accretion of smaller air bubbles oozing through the sediment. ['er ,hēv]

air hoar [HYD] A hoar growing on objects above the ground or snow. ['er ,hȯr]

air hoist [MECH ENG] A lifting tackle or tugger constructed with cylinders and pistons for reciprocating motion and air motors for rotary motion, all powered by compressed air. Also known as pneumatic hoist. ['er ,hȯist]

airhole [MIN ENG] A small excavation or hole made to improve ventilation by communication with other workings or with the surface. ['er,hōl]

air horn [MECH ENG] In an automotive engine, the upper portion of the carburetor barrel through which entering air passes in quantities controlled by the choke plate and the throttle plate. ['er ,hȯrn]

air horsepower [MECH ENG] The theoretical (minimum) power required to deliver the specified quantity of air under the specified pressure conditions in a fan, blower, compressor, or vacuum pump. Abbreviated air hp. ['er 'hȯrs,paù·ər]

air hp *See* air horsepower.

air hunger [MED] The deep, gasping respiration characteristic of severe diabetic acidosis and coma. ['er ,həŋ·gər]

air-injection reactor [MECH ENG] A unit installed in an automotive engine which mixes fresh air with hot exhaust gases in the exhaust manifold to react with any gasoline that has escaped unburned from the cylinders. Abbreviated AIR. ['er in'jek·shən rē'ak·tər]

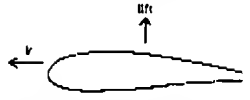
air-injection system [MECH ENG] A device that uses compressed air to inject the fuel into the cylinder of an internal combustion engine. Also known as thermactor. ['er in'jek·shən ,sis·təm]

air inlet [MECH ENG] In an air-conditioning system, a device through which air is exhausted from a room or building. ['er ,in,let]

air-inlet valve [MECH ENG] In a heating/air-conditioning system of a motor vehicle, a valve in the plenum blower assembly that permits selection of either inside or outside air. ['er ,in,let ,valv]

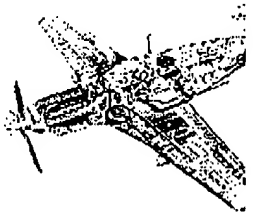
air-insulated substation [ELEC] An electric power substation that has the busbars and equipment terminations generally

AIRFOIL



Aerodynamic forces on an airfoil moving with velocity *V*.

AIRFRAME



Airframe of piston-engine P-51 pursuit airplane. *(North American Aviation, Inc.)*

private pilot manual

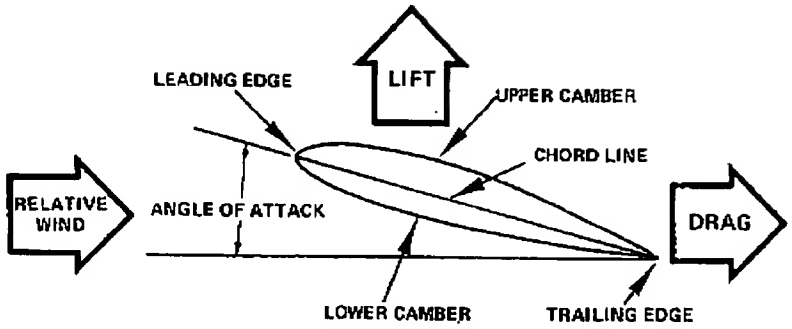


Fig. 1-26. Airfoil Terminology

The *relative wind* is the wind moving past the airfoil. The direction of this wind is relative to the attitude or position of the airfoil and it is always parallel to the flight path of the aircraft. (See Fig. 1-27.) The velocity of the relative wind is the speed of the airfoil through the air.

The *angle of attack* is the angle formed by the chord of the airfoil and the direction of the relative wind. The pitch attitude of the airfoil and the angle of attack are the same only in level flight. In other flight conditions, they are different values. (See Fig. 1-27.)

THE FOUR FORCES

An aircraft in straight-and-level flight is acted upon by four forces: lift, gravity, thrust, and drag. *Lift* is the upward acting force; *gravity*, or weight, is the downward acting force; *thrust* acts in a forward direction; and *drag* is the backward, or retarding force produced by air resistance. (See Fig. 1-28.)

Lift opposes weight and thrust opposes drag. When an aircraft is in straight-and-level flight, the opposing forces balance each other; lift equals weight and thrust equals drag. Any inequality between thrust and drag, while maintaining straight-and-level flight, will result in acceleration or deceleration until the two forces again become balanced.

LIFT

According to the Bernoulli Principle, there is an acceleration or increase in the velocity of air as the air flows around an airfoil shape; therefore, there is an acceleration of the relative wind as it flows above and below the surface of the airplane wing. Because the camber of the upper wing surface is greater than that of the lower surface, air flowing above the wing will be accelerated more than air flowing beneath the wing. The Bernoulli Principle also states that an increase in the velocity of a fluid, such as air, results in a decrease of pressure within that fluid. As a result, the reduction in air pressure above the wing will be greater than the pressure reduction along the lower wing surface. This difference of pressure accounts for the upward force called lift. (See Fig. 1-29.)

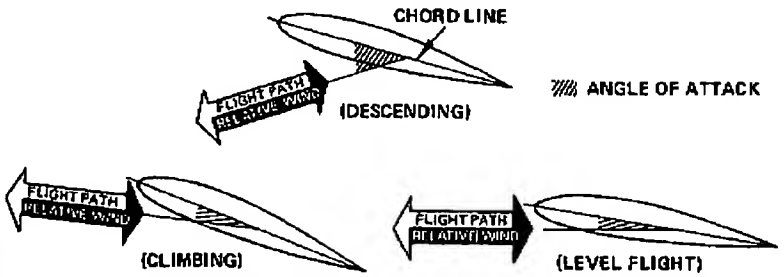


Fig. 1-27. Angle of Attack Depends Only on Relative Wind; Not on Pitch Angle

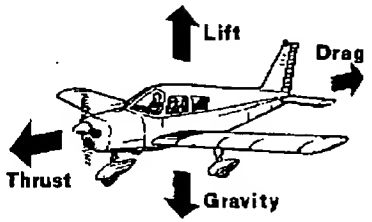


Fig. 1-28. The Four Forces Acting on an Aircraft in Straight-and-Level Flight

At *high angles of attack*, an additional force is derived from the impact of air against the lower surface of the wing because it is inclined to the relative wind. This principle may be observed by putting a hand or flat surface out of the window of a fast-moving car. The impact of the air on the bottom surface when it is inclined sharply upward creates a lifting force that is easily sensed. (See Fig. 1-30.)

Even at high angles of attack, the lift generated by the impact of air on the bottom surface of the wing amounts to only a fraction of the lifting force needed to sustain the aircraft in flight. More than 75% of the lift is caused by the lower pressure above the airfoil. The wing is not so much pushed up from below by excess air pressure as pulled up from above by a suction force.

Lift can be increased in two ways; by increasing the forward speed of the airplane or by increasing the angle of attack. The pilot can increase the forward speed of the aircraft by applying more power. This increases the speed of the relative wind over the airfoil.

THE STALL AND ITS CAUSE

Increasing the angle of attack will increase lift up to a point. As the airfoil is inclined, the air flowing over the top of the airfoil is diverted over a greater distance resulting in an even greater increase in air velocity and more lift.

However, as the airfoil is given a greater angle of attack relative to oncoming air, it becomes more difficult for the air to flow smoothly across the top of the wing. Thus, it starts to separate from the wing and enters a burbling or turbulent pattern. The angle at which airflow separation and turbulence occurs on the upper wing surface is called the *critical angle of attack*. This turbulence results in a loss of lift in the area of the wing where it is taking place.

The separation point starts near the trailing edge of the wing and progresses forward as the angle of attack is increased. (See Fig. 1-31.) Finally, the separation

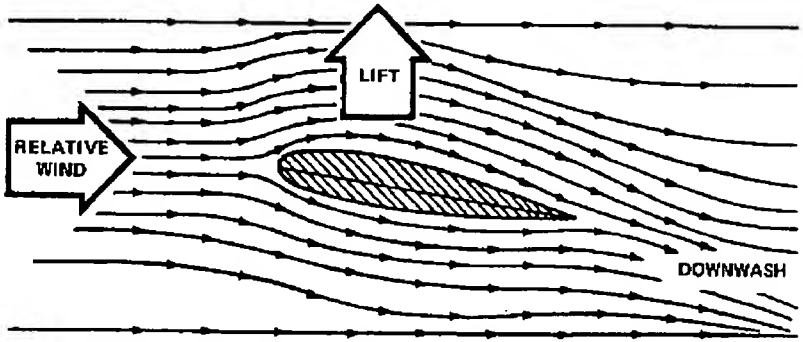


Fig. 1-29. Lift is Generated by Air Traveling Faster Above Airfoil Than Beneath

THE NEW PHYSICS IN EVERYDAY LIFE

BY

WILLIAM D. HENDERSON, PH.D.

UNIVERSITY OF MICHIGAN

LYONS AND CARNAHAN

CHICAGO NEW YORK

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straight line flight to a curved line, that is, when the aviator turns his plane, there is a tendency for the plane to roll or rotate about a longitudinal axis. To overcome this rolling tendency it is necessary for the aviator to "bank" his plane, that is to tilt it so that the outer wing system is higher than the inner. This is accomplished by means of the *ailerons*. These are auxiliary wings attached to the rear edge of the main wings. The ailerons are controlled by a sidewise motion of the stick. When the rear edge of one aileron moves up the other moves down. Their function is to secure rotational stability. The Wright brothers secured this turning stability by warping or bending the outer margins of the wings by means of a system of levers. All modern airplanes are equipped with ailerons.

The two general questions which naturally arise when we think about an airplane are these: First, What keeps the plane in the air? and second, What are the conditions for level flight, ascent, descent, and gliding? Let us take these questions up in order.

156. What Keeps an Airplane in the Air? An airplane is supported by the reaction of the air against the wings. In order to secure this reaction the plane must, of course, be in motion. To get at the answer to the question, What keeps an airplane in the air? let us consider the sectional view of the cambered wing shown in Fig. 130.

According to modern convention the direction of motion of the plane is represented by a feathered arrow. The angle which the lower face of the wing makes with a longitudinal axis is called the angle of incidence or "angle of attack." Because of the inclination of the wing the air is compressed on the under side, thus giving rise to an upward force. An upward thrust of this sort may be felt by swinging a card, which is tilted at an angle, through the air, or better still, by moving the open hand

rapidly through the water, the palm being held at an angle to the direction of motion. In the second place, on account of the curved surface of the upper side of the

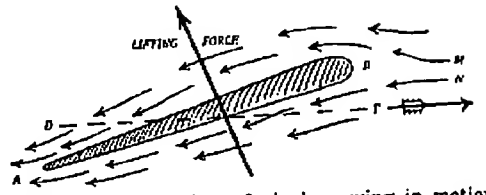

FIG. 130.—Sectional view of airplane wing in motion

wing, there is produced a diminished pressure, as the wing moves forward. To understand the reason for this diminished pressure on the upper side of the wing, let us consider two particles of air, M and N, at the leading edge of the wing. Suppose that particle M travels along the upper curved side of the wing in a curved path, and N along the under side. Now, other things being equal, the particle M on the upper side will travel with a greater speed than N, because it has farther to go in a given time. But we have learned (Art. 72) that when the speed of an air column is increased, the lateral pressure is diminished. The pressure on the upper side of the wing thus is much less than on the lower side. We then have, therefore, due to the motion of the plane, an increase of pressure on the under side of the wing and a diminution of pressure on the upper side. It is true that there are other subsidiary air reactions, but we shall not consider them here.

We may then say that an airplane is supported by the reaction of the air against the wings, there being an increase of pressure on the under side and a diminution of pressure on the upper side, resulting in a sustaining upward force, represented by the line R in Fig. 130. *It*